PACIFIC INSTITUTE

*Research for People and the Planet*

January 6, 2012

**RE: Comments on "A Methodology for Quantifying the Efficiency of Agricultural Water Use"**

To whom it may concern,

This memo addresses the December 21, 2011 draft of "A Methodology for Quantifying the Efficiency of Agricultural Water Use." The following recommendations are intended to improve the clarity of the draft document, offering suggestions to be more clear and concise.

**Maintain discussion of productivity metrics -- separate metrics based on whether they are "empirical measurements" or "modeled estimates"**

The text currently separates "methods" from "indicators." Unfortunately, there is no clear definition of either term or why they are treated differently in the report. Based on our last ASC meeting, my understanding is that "methods" are those metrics that define agricultural water-use efficiency while "indicators" are other metrics that contribute to a broader understanding of agricultural water-use productivity.

However, the most recent 2009 Water Plan (DWR 2010) defines agricultural water use efficiency as "The ratio of applied water to the amount of water required to sustain agricultural productivity. Efficiency is increased through the application of less water to achieve the same beneficial productivity or by achieving more productivity while applying the same amount of water" (Volume 4, pg. 1). This definition of agricultural water use efficiency clearly encompasses both decreased water use and increased water productivity. Thus, it is critical to include productivity metrics in this report.

In addition, it was stated that there were "better" data for methods as compared to indicators or, alternatively, that there were more confounding variables related to indicators. Yet, many of the "methods" described in the text rely on modeled estimates (e.g., crop consumptive use), whereas some of the indicators (e.g., distribution uniformity) are based on empirical measurements. In addition, there are many confounding variables in the "methods" including evapotranspiration rates, soil types, terrain, etc.

It would be far more useful to clearly separate metrics that are based on empirical measurements as compared to those that involve modeled estimates. This helps the Legislature to both understand the strengths and limitations of different metrics. For instance, empirical measurements may be more accurate but also normally require more time/money to install and monitor.

**Include a chart distinguishing the various types of water use to help readers understand the difference between consumptive uses and beneficial uses**

Suggested text: Agricultural water use can be categorized as consumptive or non-consumptive. Consumptive use refers to water that is unavailable for reuse in the basin from which it was extracted, e.g., soil evaporation, plant transpiration, incorporation into plant biomass, seepage to a saline sink, or by contamination. Non-consumptive use, on the other hand, refers to water that is available for reuse within the basin from which it was extracted, e.g., through return flows.

Agricultural water use can be further divided into beneficial and non-beneficial uses. Beneficial uses include those that contribute to crop production, including crop transpiration and leaching salts from the root zone. Non-beneficial uses include those uses that do not contribute to crop introduction, such as transpiration from weeds and riparian vegetation and evaporation from reservoirs, canals, sprinklers, soil, and plant surfaces. Beneficial use can be either consumptive or non-consumptive. Likewise, non-beneficial use can be either consumptive or non-consumptive (Figure 1).

| | Consumptive Use | Nonconsumptive Use |
|---|---|---|
| Beneficial | Crop evapotranspiration<br>Evaporation for cooling<br>Evaporation for frost protection | Water for leaching |
| Nonbeneficial | Phreatophyte evapotranspiration<br>Weed evapotranspiration<br>Spray evaporation<br>Evaporation from soil<br>Reservoir and canal evaporation | Excess deep percolation<br>Excess surface runoff<br>Operational spill |

**Figure 1. Examples of beneficial and non-beneficial consumptive and non-consumptive use** (originally published in Heerman and Soloman 2007).

Suggested Citations:

Heermann, D.F. and Solomon, K.H. (2007). Efficiency and uniformity. In: Design and operation of farm irrigation systems. 2nd edition. St. Joseph, MI: ASABE.

Peter H. Gleick, Juliet Christian-Smith & Heather Cooley (2011): Water-use efficiency and productivity: rethinking the basin approach, Water International, 36 (7): 784-798.

**Define the crop consumptive use fraction as ETAW/AW and include a discussion of the difference between evaporation and transpiration and the need for better quantification of both**

Crop consumptive use is a classic agronomic metric, most often defined as ETAW/AW. See, for example, Water Plan 2005, which calculates agricultural consumptive water use as ETAW/AW

(DWR 2009). While the total water use fraction incorporates agronomic needs and environmental objectives (by subtracting them from the denominator), it is important to have metrics that are comparable over time and therefore we recommend defining the crop consumptive use fraction in the way past Water Plans have defined it: as ETAW/AW.

In addition, there should be a discussion of the differences between the ET components and the need for better quantification of both. To not distinguish between evaporation and transpiration discounts a major component of inefficient water use: unproductive evaporation. A 2005 study, for example, found that unproductive soil evaporation was 75–85% lower with drip systems compared to flood irrigation during the early stages of cotton development (Luquet et al. 2005). Ignoring the potential to reduce such unproductive, consumptive losses may grossly underestimate potential water savings, even in regions that have already made efforts to improve efficiency. In California, nearly 60% of crops are still grown with flood irrigation, according to the most recent state survey (Orang et al. 2005). A variety of improved water management practices, including irrigation scheduling and deficit irrigation (on appropriate crops), have also been shown to reduce unproductive consumptive use (Kranz et al. 1992, Buchleiter et al. 1996, Dokter 1996, Shock 2006, Cooley et al. 2008, 2009, Christian-Smith et al. 2010). Even Seckler (1996) acknowledges the potential to reduce unproductive evaporative losses through a variety of efficiency measures:

> A study by the International Irrigation Management Institute (IIMI) [now the International Water Management Institute (IWMI)] of dry seeding rice in the Muda Irrigation Project in Malaysia showed water savings of 25 percent by eliminating pre-transplanting flooding of rice fields. Some of this was probably ‘paper’ water savings of drainage water, but some of it was undoubtedly ‘real’ water savings of evaporative losses . . . . Field evaporation losses can also be reduced by drip and trickle irrigation systems, which apply water directly to the root zone of the crop in correspondence with Eta [actual evapotranspiration].

Ignoring the difference between evaporation and transpiration can lead to serious conceptual and practical errors.

**“Indicators” are only described at the statewide and county scales (see Table 2, pg. 17), the supplier and field scales should also be included in Table 2.**

The implementation options for “methods” (including one “indicator,” distribution uniformity) are described at regional, supplier, and field scales. Yet, “indicators” are only described at statewide and county scales. The implementation options for “indicators” should be considered at finer scales, such as the supplier scale, the DAU scale, or the field scale whether or not these are “recommended.” In addition, it is useful to note that distribution uniformity is listed in the “methods” table, whereas it is defined as an “indicator” elsewhere in the text. This is a good example of the confusion that is introduced by using “methods” and “indicators.”

Sincerely,

[sent electronically; signature on file]

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